Selbyana 16(2): 141–143

USE OF SMALL LIGHTER-THAN-AIR VEHICLES FOR MOBILE ACCESS TO THE UPPER CANOPY

GRAHAM E. DORRINGTON

Department of Aeronautics & Astronautics, University of Southampton, Southampton SO17 1BJ, England

INTRODUCTION

In recent years there has been growing recognition of the ecological importance of tropical forest canopies. However, scientific studies of canopies has been hindered by the problem of gaining access to this so-called "*High Frontier*". Ingenious solutions have been found to the problem of gaining access to limited areas of canopy by using ropes, walkways and cranes, e.g. the "*Spiders Web*" technique invented by Perry.

In order to survey larger areas of the canopy (say 1km × 1km), mobile platforms are required. Helicopters have been used for aerial observation but are limited by noise and downwash from the rotor—as well as being expensive to operate. The only feasible mobile airborne platforms, capable of approaching the canopy sufficiently closely and unobtrusively, appear to be Lighter-Than-Air (LTA) vehicles.

Two classes of LTA vehicles exist. One using hot air to provide buoyancy and the other using helium or some other low density gas. If a LTA vehicle is self-propelled it is commonly known as an airship, blimp, dirigible, or powered/dirigible balloon.

In 1989 a French project "*Operation Canopée*" made use of a large thermal (hot air) airship, over 7000m³ in capacity, to deliver a large inflated raft to the top of the canopy (Hallé 1990). This innovative approach permitted several small teams of scientists, led by Hallé, to carry out scientific studies right on top of the canopy roof (Hallé & Pascal 1993). The thermal airship was also used to lift a smaller inflated 'sled' for mobile canopy studies.

In 1993, an alternative LTA approach was used by one of the world's best wildlife cameramen, G. Dieter Plage, for filming above the canopy in Sumatra. An ultralight helium filled airship, 266m³ in capacity, was used to carry a single person using a human/electric power source. The airship was successfully flown in March 1993, proving that the logistics of using a helium airship in remote forest regions were feasible. Tragically, the project ended when Plage died in an accident in April 1993. Despite this tragedy, the author believes that small helium filled LTA vehicles are a promising method of mobile canopy access.

CONSTRAINTS OF HELIUM FILLED LTA VEHICLES

Atmospheric Conditions

The principal constraints on the use of ultralight helium airships and similar vehicles (e.g. powered balloons and cable-running balloon devices), are the atmospheric conditions immediately above tropical forest canopy.

Many observers note that calm conditions prevail over many canopies up to about 100–200ft for much of the time, especially early in the mornings. Horizontal wind speeds as low as 2 knots are in fact probable over some tropical forests for much of the day and night (Aoki 1978), however not much information is available on gust conditions (fluctuations and time-scales less than 1 hour), and associated micro-meteorological effects (see Shuttleworth 1984).

Vertical air currents (thermals) are also of importance because helium airships cannot alter their buoyancy widely. Again many observers note the atmosphere immediately above the canopy is relatively quiescent. Clearly these observations need to confirmed before LTA vehicles can be used.

Size and Power

In order to carry a single person in tropical conditions (at low altitude) a helium envelope capacity of about 150–300m³ is necessary. This volume increases to 300–500m³ if two persons are carried, etc. If the envelope (gas bag) is made to be streamlined to reduce its aerodynamic drag, it would have a length-to-diameter ratio of about 2–4. Hence such an envelope would be 16–25m in length. The power required to move this envelope through the air, at a speed of 5–10 knots (a minimum requirement), is about ½–1½ hp or 300–1000W. Hence battery-electric powered LTA vehicles are possible, circumventing the need for piston engines which are more noisy and not easy to use in a pulsed on-off mode.

Safety

The two main concerns of the use of a LTA vehicle close to the canopy are as follows:

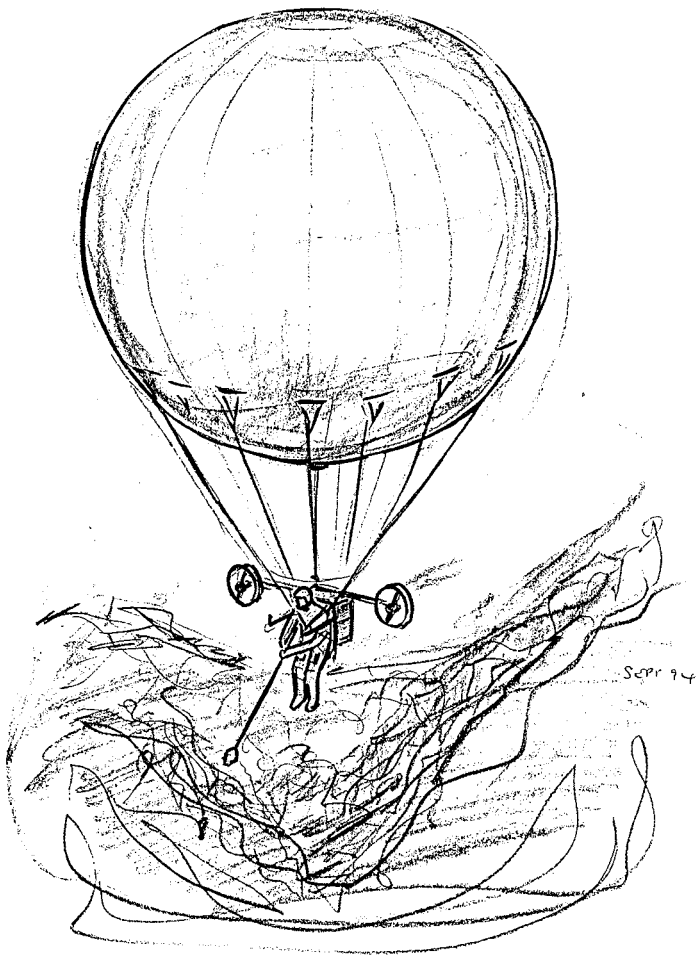

FIGURE 1. Sketch of a small 'powered balloon' (7m in diameter), single person manoeuvring unit, under study.

1. the possibility of irreversible entanglement with the canopy. In this case, it is essential to fit the airship with a safety—descent system i.e. abseiling equipment, permitting the crew to descend to the ground. This system is complicated in view of the problem of off-loading a near-neutrally buoyant airship, but appears to be no less safe than existing canopy-rope access methods.
2. the possibility of rapid deterioration in weather conditions. This risk can be minimised by continuous monitoring of wind speed in a control zone outside to the airships operational area, possibly assisted by local airfields in the region. In the event of wind speeds, becoming too high for controlled flight it would be necessary to vent and land on canopy and evacuate the airship. Clearly it is necessary to provide an adequate venting system and provide adequate control in vertical air currents. Obviously, a good knowledge of the local meteorology is also needed. The use of small, unmanned, tethered, blimps to carry radio-telemetered anemometers, is a sensible way of determining wind speeds above the canopy.

Costs

Operational costs of the system would be dominated by transport logistics and helium costs. A packaged system could weigh between 200–1000kg. It would require expert supervision during inflation and preliminary operation. Helium costs vary widely between countries and have to investigated on a case-by-case basis. However, it should be stressed that helium costs will probably not dominate, because in recent years, he-

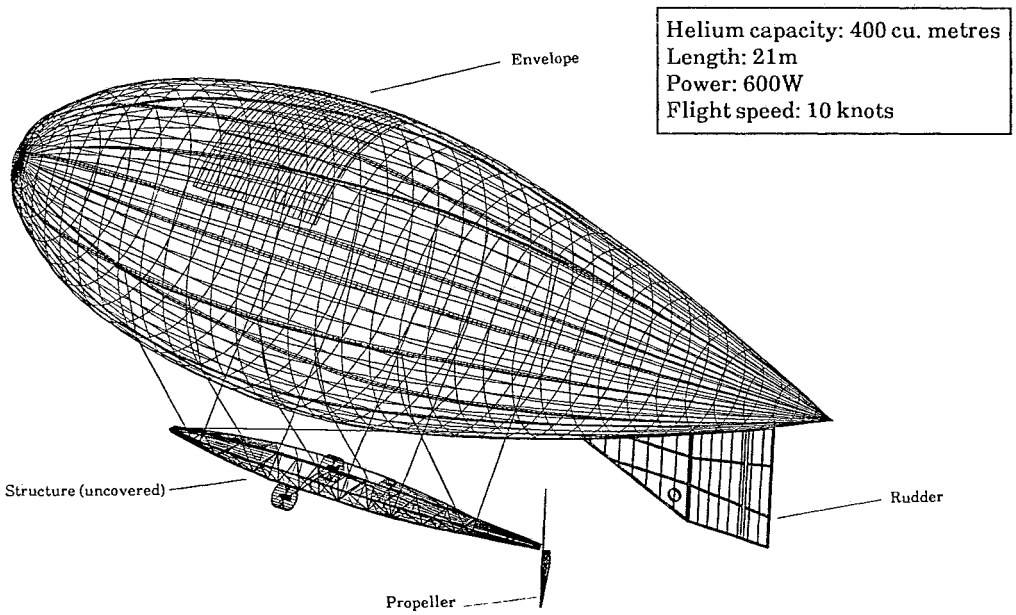

FIGURE 2. Schematic diagram of airship for "Project Hornbill".

lium has become cheaper and more available worldwide.

POSSIBLE SYSTEMS

Several systems appear worthy of investigation:

1. A traditional airship configuration where the crew gondola/structure hangs below a streamlined envelope. The use of vectored thrust and bow/tail thrusters would improve manoeuverability.
2. A single person 'powered balloon' system, where a small envelope with a squat/spherical shape about 6–8m in diameter is used to permit high manoeuvrability, see Figure 1.
3. A cable balloon system in which helium envelope is used to carry to mass of the scientist and their equipment, along a cable or web of ropes.

ON-GOING ACTIVITIES

It is hoped that "*Project Hornbill*" will soon be started in Sabah, Malaysia to evaluate a two-seat, 400m^3, electric powered airship for forest canopy studies and for radio-tracking of sub-canopy species, etc. The airship to be used in the first phase of this project has already been constructed in Southampton, see Figure 2.

The University of Stuttgart has investigated the use of a smaller unmanned remotely piloted helium airship in Germany.

CONCLUDING REMARKS

The use of LTA vehicles appears to be promising. A small helium filled airship could provide a useful 'taxi' system to permit studies of large areas of forest canopy. It could complement the use of a (larger) thermal airship, or provide an alternative in regions where helium is readily commercially available. Widespread application of LTA vehicles may be possible if the safety/cost aspects of the system can be proven. As Hallé has pointed out, there is an analogy with the application of the sub-aqua lung and the exploration of coral reefs. Could future LTA vehicles provide the same degree of freedom to canopy researchers?

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